GENOTYPIC VARIATION IN COMMON BEAN IN RESPONSE TO COLD TEMPERATURE STRESS

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Beans (Phaseolus vulgaris) are regarded as a susceptible crop to suboptimal temperatures. In temperate regions of the world, low temperature is a limiting factor for bean production at establishment when beans are planted early during the growing season to maximize the use of the available growing period.
Two experiments were conducted to study genotypic variation in common bean cultivars/lines to low temperature stress. The first experiment was carried out to test the germination response of 14 different cultivars/lines under 4 constant (8, 10, 12, or 18 C) and 3 alternating suboptimal temperatures (10/8, 12/8, or 18/8 C) in petri dishes. At constant low temperatures, the greatest differences between phenotypes occurred at 8 C, based on % germination, but at 12 C, based on germination rate. Significant positive correlation (r = 0.74 - 0.98) between germination rate and % were observed in screening for cold-tolerant germplasm at 8, 10, 12, 10/8, 12/8 and 18/8 C. Phenotypes that germinated best at 8 C were 'Volare', 'Great Northern (G.N.) Tara', 'G.N. Belneb #1', 'G.N. Spinel', and 'San Cristobal'(Table 1). Germination of 'Pinto-UI-111' and 'Canadian Wonder' increased greatly when temperatures were increased by 2 to 4 C for 2 hr per 24 hr, compared to a constant 8 C, whereas, germination of 'G.N. Spinel' and 'G.N. Belneb # 1' was reduced. This revealed that alternating low temperature identified additional cold-tolerant phenotypes, which may be a more suitable technique for selecting germplasm with satisfactory germination at low temperature for use in the Mediterranean region. Tetrazolium tests showed variation in seed viability of the nongerminated seeds when imbibed at suboptimal temperatures for 14 days among bean phenotypes (Table 2). 'Michigan 84100', 'Canadian Wonder', and M-9037 showed high percent seed viability at low temperatures. Indicating the importance for the breeder to include a viability test in future screening for cold-tolerant cultivars to select genotypes with seeds that remain viable until the germination medium is warm enough and does not rot and die at suboptimal temperature.
In the second experiment, protein extraction from seedlings exposed to low temperature were analyzed using electrophoretic techniques to evaluate four cold-tolerant and three cold-sensitive cultivars/lines (selected based on performance in the seed evaluation part). Seeds were germinated at 18 C constant for 96 hr, or for 48 hr followed by 2 or 8 C for 48 hr. 'Volare', 'G.N. Tara', 'Pinto-UI-111', and 'Canadian Wonder' showed increase in polypeptide patterns having molecular weight of about 66 KDa and above, moreover, 'G.N. Tara' and 'Canadian Wonder' showed increase in polypeptide bands of lower molecular weight of about 33 KDa. While Alubia-33-1, 'Michigan 84100', and BAT-1225 showed no changes

Table 1. Percent germination of 14 bean cultivars/lines after 14 days at constant or alternating suboptimal temperatures.

Phenotypes	TEMPERATURES (C)						
	CONSTANT				ALTERNATING [z]		
	8	10	12	18	10/8	12/8	18/8
Volare	95.0a[y](ab)[x]	90.0abc (b)	98.3ab (a)	95.0ab (ab)	100.0a (a)	100.0a (a)	96.7ab (ab)
G.N. Tara	85.0a (ab)	81.7abcd(b)	88.3abc (ab)	96.7ab (a)	91.7a (ab)	88.3bcd(ab)	98.3ab (a)
G.N. Belneb #1	95.0a (b)	85.0ab (b)	85.0c (b)	93.3abc(ab)	66.7c (c)	83.3cde(b)	100.0a (a)
G.N. Spinel	78.3a (bc)	78.3cd (bc)	86.7bc (ab)	91.7abc(ab)	70.0bc (c)	68.3fg (c)	100.0a (a)
San Cristobal	73.3a (c)	91.7abc (b)	98.3ab (ab)	98.3ab (ab)	98.3a (ab)	100.0a (a)	98.3ab (ab)
Michigan 84100	46.7b (b)	40.0fg (bc)	43.3f (bc)	83.3c (a)	28.3e (bc)	38.3hi (bc)	78.3d (a)
Blanco	46.7b (c)	68.3de (b)	93.3bc (a)	96.7ab (a)	46.7d (c)	65.0g (b)	93.3abc(a)
Pinto-UI-111	45.0b (b)	96.7a (a)	93.0abc (a)	100.0a (a)	91.7a (a)	96.7ab (a)	100.0a (a)
Canadian Wonder	40.0bc (c)	95.0ab (a)	96.7abc (a)	100.0a (a)	78.3b (b)	93.3abc(a)	100.0a (a)
BAT-1225	21.7bcd(c)	91.7abc (a)	100.0a (a)	98.3ab (a)	13.3f (c)	73.3efg(b)	98.3abc(a)
BAC-89	20.0cd (e)	80.0bcd (bc)	95.0abc (ab)	96.7ab (a)	48.3d (d)	78.3def(c)	88.3c (abc)
M-9037	8.3d (c)	41.7fg (b)	45.0e (b)	86.7bc (a)	6.7f (c)	36.7i (b)	91.7bc (a)
Jamaica Red	6.7d (c)	76.7cd (b)	98.3ab (a)	100.0a (a)	11.7f (c)	90.0abc(a)	91.7bc (a)
Alubia-33-1	3.3d (g)	31.7g (e)	61.7d (c)	100.0a (a)	16.7f (f)	48.3h (d)	78.3d (b)
C.V. (%)	28.7	11.5	7.0	6.5	11.5	8.0	4.2

[z] Twelve hours per day at each temperature.

[y] Phenotypes are compared within each temperature by LSD at $P \leq 0.05$. Means with the same letter within columns are not significantly different.

[x] Temperature are compared within each phenotypes by LSD at $P \leq 0.05$. Means with the same letter within rows are not significantly different.

Table 2. Percent viability [z] of the nongerminated seeds of 9 bean cultivars/lines after 14 days at constant or alternating suboptimal temperatures

Phenotypes	TEMPERATURES (C)						
	CONSTANT				ALTERNATING [y]		
	8	10	12	18	10/8	12/8	18/8
Michigan 84100	73	82	96	* [x]	77	92	*
Blanco	50	66	*	*	97	100	*
Pinto-UI-111	0	*	*	*	*	*	*
Canadian Wonder	79	*	*	*	*	*	*
BAT-1225	0	*	*	*	21	6	*
BAC-89	11	*	*	*	13	*	*
M-9037	100	97	95	*	100	100	*
Jamaica Red	0	*	*	*	0	*	*
Alubia-33-1	0	20	73	*	26	59	*

[z] Tetrazolium test was used to determine the viability of nongerminated seeds, which were cut in half and soaked overnight in 4 mL of 0.1 % 2, 3, 5-tripheryl tetrazolium chloride at 30 C.

[y] Twelve hours per day at each temperature.

[x] * = No tetrazolium test was conducted, percentage germination $\geq$ 75 %.

in polypeptide patterns if compared to the control (96 hr at 18 C in the dark). Suggesting the importance of using the electrophoretic technique as a method of selecting for cold-tolerant genotypes.